Problem 4.21: Unusual Amplitude Modulation

We want to send a band-limited signal having the depicted spectrum (Figure 4.29(a)) with amplitude modulation in the usual way. I.B. Different suggests using the square-wave carrier shown below (Figure 4.29(b)). Well, it is different, but his friends wonder if any technique can demodulate it.

1. Find an expression for $X(f)$, the Fourier transform of the modulated signal.
2. Sketch the magnitude of $X(f)$, being careful to label important magnitudes and frequencies.
3. What demodulation technique obviously works?
4. I.B. challenges three of his friends to demodulate $x(t)$ some other way. One friend suggests modulating $x(t)$ with
$$cos(\frac{\pi t}{2})$$
, another wants to try modulating with
$$cos(\frac{3\pi t}{2})$$
and the third thinks cos 2 will work. Sketch the magnitude of the Fourier transform of the signal each student's approach produces. Which student comes closest to recovering the original signal? Why?
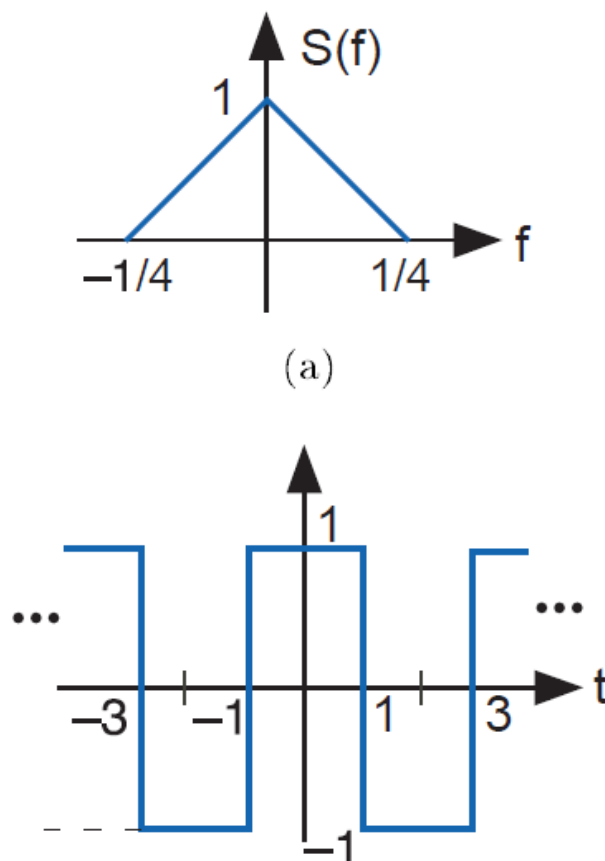

(a)

Figure 4.29 Unusual Amplitude Modulation